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GUIDE FOR THE SELECTION OF AGRICULTURAL SOILS

by

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INTRODUCTION

In evaluating a farm property and in estimating the chances of making a satisfactory living from it, the nature of the soil, among many other things, must be given serious consideration. The first essential of success in farming is to have a fertile soil that is adapted to the crops which are to be grown on it. However, in addition to productivity, other factors relating to the soil, such as the cost of tillage and other management operations, must be kept in mind. In this bulletin an endeavour is made to point out the main factors that should be observed in examining farm land.

SUGGESTIONS FOR THE EXAMINATION OF SOILS

Nearly all soils have more or less distinct layers or horizons from the surface to the unaltered mineral material from which they have been formed. The cross section of horizons from the surface to the parent material is known as the soil profile. A soil may have few to many of these horizons, but in this outline the upper, darker horizon is referred to as the surface soil, the unaltered or slightly altered parent mineral material is referred to as subsoil, while the horizons lying between the surface and the subsoil are grouped under the term sub-surface soil. Since many of the inherent soil characteristics can be observed only in the soil profile, it is necessary for the examiner to make free use of a spade or shovel. The use of augers for examining the soil profile is not generally advisable.

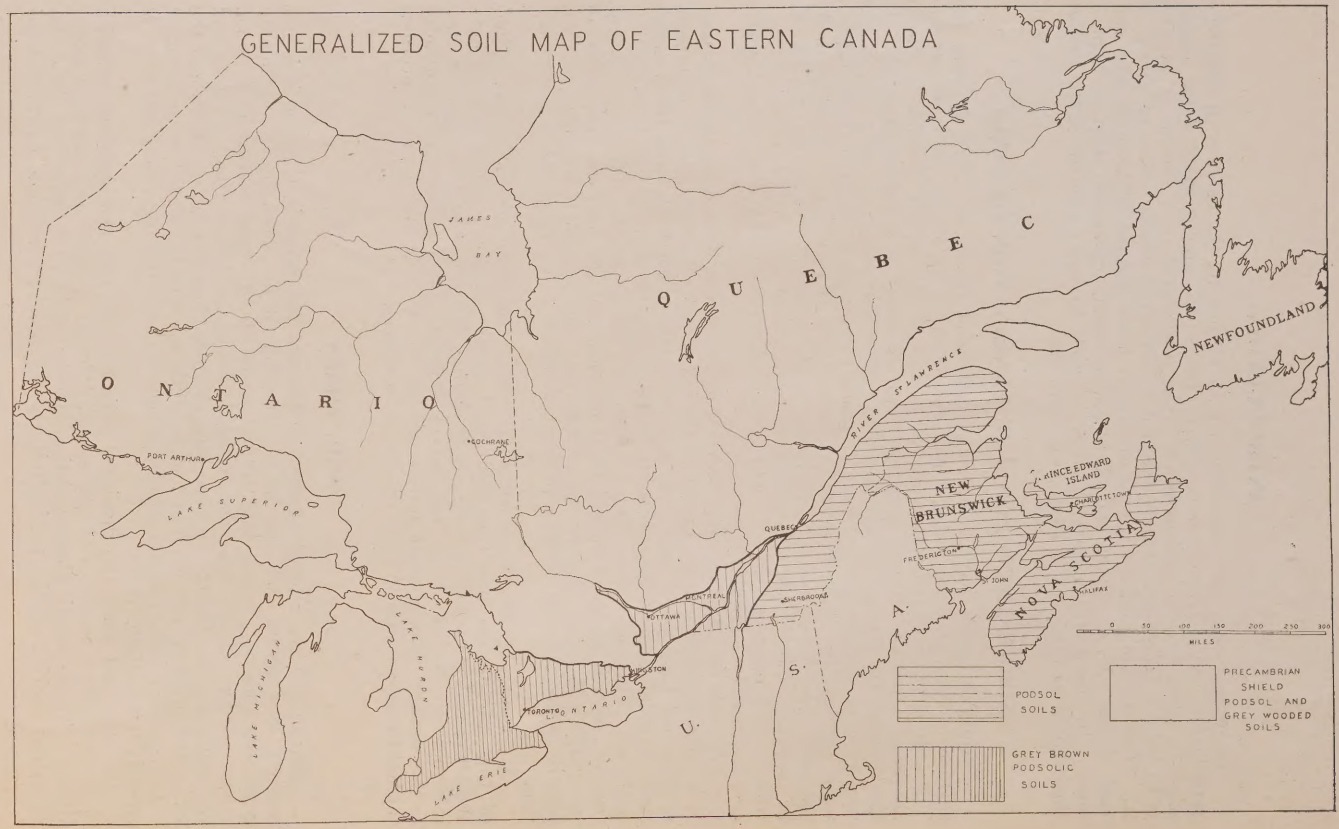
The soils on any farm may vary from each other to a considerable extent. It is desirable to know the extent of these variations as they are of importance in practical farm operations. Since it is usually difficult to keep these variations in mind, a good practice is to make a map or chart of the farm as it is inspected. On such a map the location and extent of the different soils and features related to them should be indicated; also the location and extent of the cultivated land, pasture, woodland, etc. Such a map will give a clear picture of the property under consideration which will greatly aid in its evaluation.

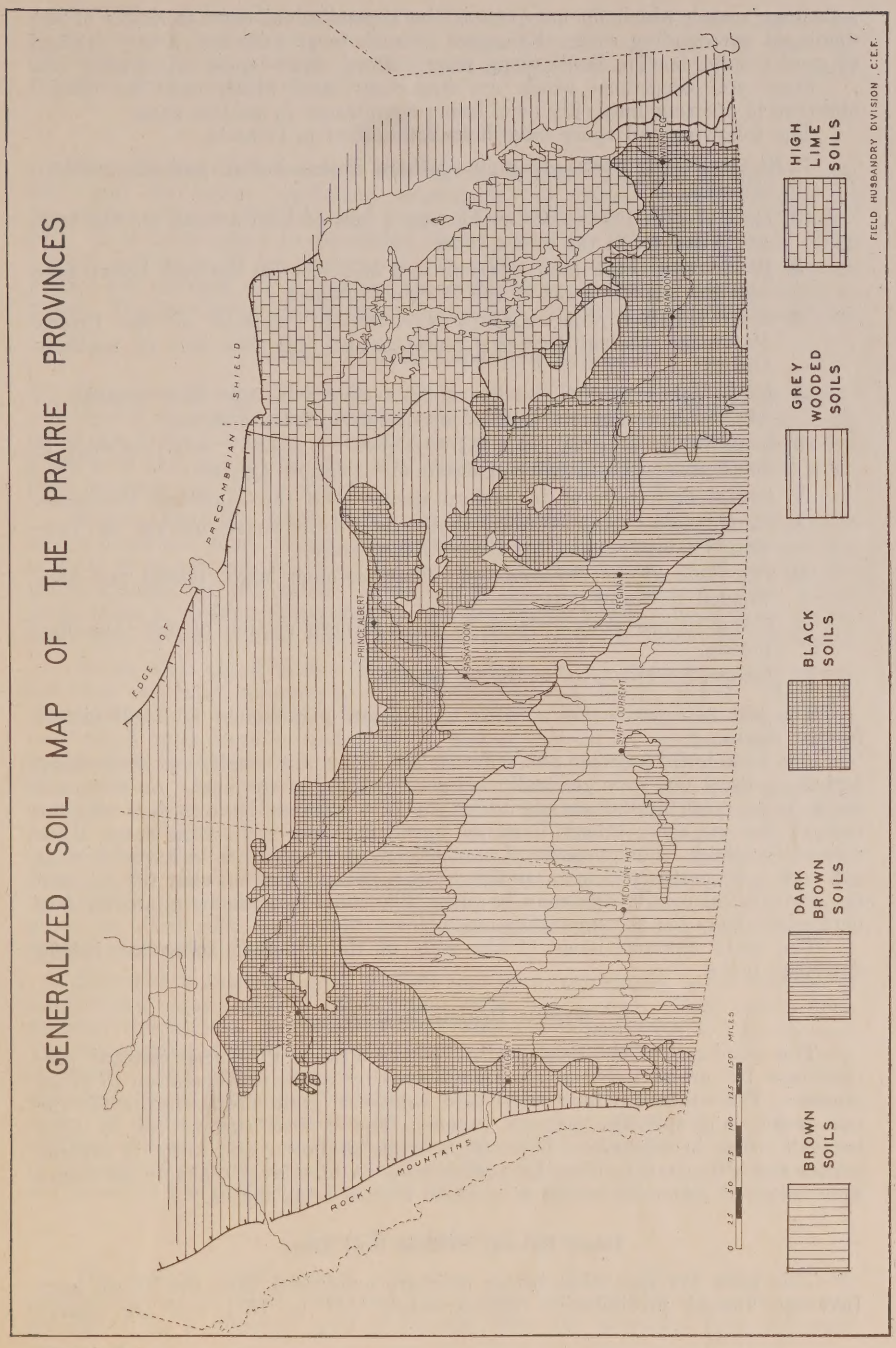
A considerable amount of soil survey work has been done in Canada. Much of this information has been published in the form of maps and reports. Wherever soil maps and reports are available, full use should be made of such information. A list of the soil survey organizations in Canada is appended to this outline. These organizations will be able to give information concerning the nature of the soils in their respective provinces.

SOIL ZONES

Since there are a great number of different soil types in Canada, it is not possible to describe each one here. However, it has been found possible to group the soils of Canada into several zones on the basis of certain common characteristics. These soil zones coincide closely with the broad climatic and vegetative zones. Hence the type of agriculture that can be practised and the kinds of crops that can be grown successfully are closely related to these major soil zones. For this reason a discussion on the characteristics of the soil zones is given in this outline.

In each soil zone, the dominant soils have certain specific characteristics in common, as a result of the influence of broad climatic and vegetative conditions. These zonal characteristics can be recognized and they have an important bearing on the productivity of the soil. In addition, however, local


GENERALIZED SOIL MAP OF EASTERN CANADA
ONTARIO
QUEBEC
JAMES BAY
COCHRANE
PORT ARTHUR
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
TORONTO
KINGSTON
OTTAWA
MONTREAL
SHERBROOKE
QUEBEC
RIVER ST. LAWRENCE
NEW BRUNSWICK
FREDERICTON
ST. JOHN
PRINCE EDWARD ISLAND
CHARLOTTETOWN
NOVA SCOTIA
HALIFAX
NEWFOUNDLAND
U. S. A.
0 50 100 150 200 250 300
MILES
PODSOL SOILS
PRECAMBRIAN SHIELD PODSOL AND GREY WOODED SOILS
GREY BROWN PODSOLIC SOILS


GENERALIZED SOIL MAP OF THE PRAIRIE PROVINCES
EDGE OF PRECAMBRIAN SHIELD
ROCKY MOUNTAINS
PRINCE ALBERT
SASKATOON
REGINA
SWIFT CURRENT
MEDICINE HAT
CALGARY
EDMONTON
WINNIPEG
BROWN SOILS
DARK BROWN SOILS
BLACK SOILS
GREY WOODED SOILS
HIGH LIME SOILS
0 25 50 75 100 125 150 MILES
FIELD HUSBANDRY DIVISION, C.E.F.

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soils may occur, which do not possess the typical zonal characteristics of the dominant surrounding soils. Examples of such local soils are, poorly-drained or mucky soils, bottom lands along river valleys, dyke lands, saline soils, etc.

Some soil conditions which are important, and which must be closely observed in one zone may only be of minor significance in another zone.

The following soil zones have been established in Canada.

1. *Brown Prairie Soils.*—Occupy southern Saskatchewan and southeastern Alberta.
2. *Dark Brown Prairie Soils.*—Occupy a belt of land around (to the east, north and west) the brown zone.
3. *Black Soils* (Park land).—Occur in a belt between the dark brown zone and the wooded areas of the Prairie Provinces.
4. *Grey Wooded Soils.*—Occupy the wooded sections of the Prairie Provinces, central British Columbia and the clay belt of northern Ontario.
5. *High-Lime Soils* (Rendzina soils).—Occur in the lake regions of Manitoba and in a section of northeastern Saskatchewan.
6. *Grey-brown Wooded Soils* (Grey-brown "podsolic" soils).—Occur in southern and southeastern Ontario and southern Quebec.
7. *Podsol Soils.*—Occur in eastern Quebec and the Maritime Provinces.
8. *Pacific Coast Soils.*—Occur along the Pacific coast, mainly on Vancouver Island and in the Fraser River Valley.
9. *The Soils of the Precambrian Shield.*—Rough lands, podsol and grey wooded soils and peat.
10. *Forest-tundra Soils.*—Occur in the northern section of the Canadian forests.
11. *Tundra Soils.*—Occur in the far north.

The last two groups are of little agricultural significance and will not be further discussed.

The boundaries between the different soil zones are usually not very sharp and the soils of one zone gradually merge into those of the next. As the zones are so large, most individuals examining the land will only have to deal with the soils of the one zone; others, however, may have two or, in some cases, three zones to consider. For purposes of comparison, it is important to know in what soil zone a property is located, as this gives a general idea of what the soil and the agricultural possibilities may be like. The soil zones can be approximately determined from the accompanying maps.

The main characteristics of the soils of the different zones are briefly described below.

Brown Prairie Soil Zone

This zone covers the drier section of the Prairie Provinces (annual precipitation 14″ or less) and it is characterized by a native vegetation of short grasses. The cultivated land is devoted chiefly to grain production, while the non-arable land provides pasture ranges. The typical surface soil is light to drab brown in colour and is on the average shallower and lower in organic matter and nitrogen than the other prairie soils. A lime layer (calcium carbonate accumulation) generally occurs at a depth from 6 to 12 inches.

Dark Brown Prairie Soil Zone

This zone has somewhat better moisture conditions than the brown zone (average annual precipitation approximately 14″ to 16″) and the native

vegetative cover is somewhat heavier. The typical surface soils are dark brown in colour and contain somewhat more organic matter and nitrogen than the brown soils. Their average depth is also greater. The lime layer is usually found at depths of 10 to 18 inches.

Black Soil Zone

The climate of this zone is sub-humid (annual precipitation usually over 16") and the native vegetation consists of tall grasses with occasional to numerous clumps of shrubs and trees. It is often referred to as the "Park" belt. It is more suited to diversified farming than the other prairie soils. The typical surface soils are dark brown to black in colour and rich in organic matter and nitrogen. The depth of the surface layer may vary from 4 inches to 2 feet. The lime layer usually occurs between 15 and 36 inches below the surface.

Other Soils in Grassland Zones

Degraded Black.—The soils under woodland, especially toward the northern edge of the black zone, often have a more or less pronounced greyish layer or horizon in the lower part of the surface soil. These soils are known as degraded black soils and, as they are generally lower in fertility than the true black soils, their presence should be indicated.

Swamp Podsols.—Small poorly drained depressions or sloughs often occur in the black soil zone. Some of these sloughs form permanent swamps and are of little or no agricultural value, but many of the depressions, which are not too badly drained, are cultivated. Their surface soil is light grey in colour, which gives them a striking appearance. The fertility of these soils is much lower than that of the typical black soils and their presence should be indicated.

Saline and Alkali Soils.—These soils occur in all three grassland zones, but they are most common in the brown and dark brown zones. They are characterized by undesirable amounts of soluble salts. As a rule, the saline and alkali soils have a characteristic native vegetation such as salt grass, greasewood, gumwood and wild barley. Patches of bare ground encrusted with salts are also frequently encountered on these soils. Alkali soils generally occur in valleys and depressions that receive drainage from surrounding soils and from which there is no drainage outlet. However, alkali may occur in level land that is not well drained even though the land is slightly elevated. Most of the alkali soils are non-arable, although the less salty types may be used for the production of alkali-tolerant crops. The feeding value of plants grown on alkali soils is generally lower than that of upland hay which has been grown on non-alkali soils.

Blow-out or Burn-out Soils.—These soils occur principally in the brown and dark brown zones and to a lesser extent in the black zone. They have a very compact, impervious and waxy subsoil, and a comparatively friable surface. The lower part of the surface soil is often greyish in colour and has a platy structure. The upper part of the subsoil consists of grey-topped, rounded columns. Small depressions varying in size and number usually occur on these soils. In these depressions the surface soil has been blown off, exposing the compact sub-soil. Such depressions have very little vegetation and the number of depressions present largely determines the value of the land. Blow-out soils are generally less productive than the adjacent normal soils.

Grey Wooded Soil Zone

The natural vegetation in this zone is woodland. These soils are less productive than the black soils, and they present entirely different problems and are suited for a different type of farming than the grassland soils discussed

previously. The typical soils under wooded conditions have a grey, leached, ash-like layer or horizon near the surface, immediately below a thin dark leaf mould. The cultivated surface layer usually varies from dark to light grey in colour. Under dry conditions, the soil is usually much lighter in colour than when moist. The lime layer in these soils is usually encountered between two and four feet below the surface. In local open meadows and park areas, the soil may have a dark layer of varying thickness on the surface over the ash-like grey layer. These are degraded black soils similar to those described earlier. Many local poorly-drained depressions are often covered with peat and muck, which will be briefly described later.

High-Lime Soil Zone

These soils have been formed from limestone materials and the excessive amount of lime in the soil has a great effect on the properties of the soils and on their productivity. These soils usually have a thin black or greyish surface soil which may only be a few inches thick. The entire depth of the soil is often only a foot or even less. The underlying material is light grey in colour and usually contains many limestone fragments. Stones are frequently very numerous on the surface. There is considerable local variation between the soils of this zone and extensive poorly-drained areas are covered with peat or muck, especially in the northern section of the area. The productivity of the high-lime soils is not very high and the crops often suffer from drought and from a lack of phosphorous. The soils seem to be definitely better suited for some crops than for others.

Grey-Brown Podsolic Soil Zone

This soil zone is suited for a very diversified type of farming and the soils differ greatly in their appearance and productivity. The typical grey-brown podsolic soils have developed under deciduous forest and usually have a thin dark surface soil over a greyish-brown leached layer which rests upon a darker brown layer or horizon. The leaching in these soils has not been nearly so severe as in the podsol soils, which will be discussed later. The well-drained cultivated surface soils are usually greyish-brown in colour, while, in the depressional and level areas, which are often poorly drained, the surface soils are usually darker brown to black in colour. Black muck and peat are often found in poorly-drained depressional areas.

The soils of this zone vary considerably from southwest to northeast. In the southwestern sections, south and west of the Niagara escarpment, the soils are usually more deeply weathered than east of the escarpment. It may be said that these soils are more mature; the grey-brown layer often extends to twenty inches or more in depth and the underlying brown layer is well developed. The reaction of these soils varies from alkaline to moderately acid. Between the escarpment and the Precambrian Shield, the soils are usually shallower and the average depth of the grey-brown layer is less than in the soils west of the escarpment. However, along the eastern and northern edges of the area, the leached layer is often somewhat lighter in colour indicating more intensive leaching. In certain sections of the area, the soils are very high in lime and they resemble in this respect the high-lime soils of Manitoba. However, they are, as a rule somewhat deeper and less stony, and consequently more fertile than the Manitoba high-lime soils. The reaction of the soils in this area varies from alkaline to moderately acid. Between the Precambrian Shield and the highland of the Eastern Townships of Quebec, the heavier soils are usually immature, that is they do not show distinct and striking layers in the soil profile or the vertical cross-section of the soil, although indications of a shallow grey brown, leached layer are visible. The light sandy soils in this section,

especially on flat to depressional areas, have a distinct light grey to white, ash-like, leached layer immediately below a thin darker surface layer. These local sandy soils have the same general characteristics as the true podsol soils, which will be discussed below. Their reaction varies from moderately to strongly acid, while the heavier clay soils are from slightly alkaline to moderately acid in reaction.

Podsol Soil Zone

A podsol soil is a leached acid soil which under undisturbed wooded conditions has a distinct light grey, ash-like layer near the surface, below the leafmat and has a brown to reddish brown or red sub-surface layer. The podsol soils are more severely leached than the grey-brown podsolic soils and although the leached layer is often not so deep as in the grey-brown soils, it is usually much lighter in colour. The depth of the ash-like layer differs considerably in the soils of the podsol zone in Eastern Canada and may vary from 1 to 12 inches in thickness. The depth and the extent to which the ash-like layer has been developed is usually related to the fertility of the soil. Generally, the podsol soils are less fertile than the grey-brown podsolic soils. The well-drained cultivated soils are usually greyish-brown in colour, but they also may be reddish-brown to red in colour, and they often have light grey to white streaks or patches.

There is much local variation between the soils of this zone due to the nature of the mineral materials from which the soils have formed and due to topography and drainage conditions. The most striking examples of the influence of the mineral material are the red soils of Prince Edward Island and of certain sections of Nova Scotia and New Brunswick. These soils have acquired their characteristic red colour from the underlying red sandstone, from which the mineral materials have been derived. Nevertheless, these soils have all the inherent characteristics of true podsol soils and the ash-like layer can be observed under forest cover. There are many less striking, but, in some cases, more important, soil variations which have been brought about by differences in the nature of the mineral materials.

The cultivated surface soils in depressional and poorly-drained areas are usually darker in colour than the surrounding well-drained soils, but in many cases, they are ashy-grey. The poorly-drained, dark soils are as a rule less leached, and the ashy-grey soils more leached than the surrounding well-drained soils. Many poorly-drained areas are covered with peat or with comparatively shallow black muck.

The bottom lands in the river valleys, as well as the dyke lands, do not exhibit the characteristics of podsol soils. They lack the grey leached layer and have a drab-coloured sub-soil. These soils are usually more fertile than the typical upland soils. The reaction of the unlimed upland soils usually varies from moderately to strongly acid, while the bottom lands vary in reaction from slightly acid or neutral to strongly acid.

Soils on the Precambrian Shield

Most of the Precambrian Shield consists of rough lands containing large areas of rock outcrops and of peat. The agricultural land on the Shield is mainly confined to small areas in river valleys, to some of the smoother ridges along the southern edge of the Shield and to some more or less isolated larger smooth areas. Most of the isolated areas are old lake beds between the rough outcrops of the Shield. The most notable of such areas are, the Lake St. John and Abitibi districts in Quebec and the New Liskeard, the Cochrane-Hearst (northern clay belt) and the Rainy River areas in Ontario.

The soils in these areas vary from typical podsols to typical grey wooded soils, similar to those of the northern sections of the Prairie Provinces. Many

of these soils are fairly heavy in texture and some of them make reasonably good agricultural land. Poor surface, and especially poor internal drainage conditions of the soil, together with varying thicknesses of muck and peat on the surface of the soil often limit the use of the land for agricultural purposes.

Soils of the Pacific Coast

The climate of this zone is characterized by mild winters with heavy rainfalls and fairly dry summers. The native vegetation consists of heavy stands of timber.

The zonal soils are characterized by a low content of organic matter, by a yellowish-brown to reddish-brown surface soil, and by a relatively high acidity as compared with the grey wooded soils or the prairie soils.

Agriculture on these zonal soils is limited, most of the farming, particularly in the Fraser River Valley, being done on flood plains and deltas. These soils have not the characteristics of the zonal soils, as they are of comparatively recent origin. They are comparatively fertile; their productivity is largely related to texture, drainage, colour, etc., points which are discussed separately.

Peat Soils

Peats occur as local soils in all the more humid soil zones and they are not found in the brown and dark brown prairie zones and only to a limited extent in the black soil zone. They have formed in poorly-drained depressional areas which, in many cases, were formerly covered with stagnant lakes. Peats consist of dead plant remains which have undergone decomposition to various degrees. However, the decomposition has not proceeded far enough to destroy the fibrous plant tissue. Peats are usually brown in colour and very acid in reaction. They differ very greatly, depending on the kind of plants from which they have formed. Peats are generally not suitable for agricultural production, but some of the deeper deposits of good quality peat have some commercial value.

Black Muck

The black muck soils have somewhat the same origin as peats and their general distribution is also the same, but their most common occurrence is in the grey-brown podsolic zone. The organic plant remains in the black muck soils have been fairly well decomposed and the plant remains have lost most of their fibrous structure. The muck soils are dark brown to black in colour and they are more or less mellow and structureless. Most of the black muck soils have been formed largely from grasses, sedges, and from tree remains, and they contain only comparatively small percentages of moss remains. The quality of the muck soils depends to some extent on the kinds of plants from which they have been formed. The muck soils are usually less acid than the peat soils, but they may vary from neutral to very acid in reaction.

Black muck soils are often valuable agricultural soils if they are well-drained, yet not drained excessively. They are especially well suited for market garden crops, but many of the ordinary farm crops are not so well adapted to muck soils.

The Soils in the Interior Valleys of British Columbia

In the Okanagan, Thompson, and in some of the other semi-arid valleys in British Columbia, the soils vary greatly and a definite succession of changes can be observed as one proceeds from the bottom of the valleys up the slopes to the timber lines. The soils on the bottom of the slopes are greyish-brown to brown in colour resembling the brown prairie soils. In the southern and more arid sections of the valleys, these brown soils extend farther up on the slopes

than in the northern and less arid sections of the valleys, where the brown soil may only be confined to a narrow fringe, or may be entirely absent. The soils on the slopes above the brown soils are dark brown in colour similar to the dark brown prairie soils. Above the dark brown soils, and just below the timber line, the soils are usually black in colour, and they possess similar characteristics as the black prairie soils. The wooded soils above the valleys are heavily leached and they resemble the grey wooded and podsol soils.

LOCAL CONDITIONS TO BE OBSERVED

Mineral Soil Materials

The kind of mineral material from which the soils have formed often has an important bearing on the productivity of the soil. The mineral soil material may be subdivided according to its uniformity which is closely related to the way in which it has been deposited. The following broad groups should be recognized: (1) Glacial till—usually lacks uniformity and contains various amounts of stone. The soils usually have an undulating to rolling topography and are seldom level over appreciable areas; (2) Lacustrine material—usually is very uniform, heavy in texture and seldom contains stones. Thin horizontal bands of clay or silt are often noticeable in the subsoil. The topography is usually level or gently undulating. (3) Outwash material is usually, to a greater or lesser extent, sandy or gravelly in texture, and layers varying in texture are often noticeable. It is often deposited as overwash on lacustrine clay or till. Large stones are usually absent, but they may occur. (4) Residual material—The soil has formed from weathered, decomposing rock. The kind of rock should be observed if possible. (5) Wind blown material—usually is fairly uniform and light to medium in texture. Stones are usually absent. The topography is often in form of dunes. (6) Recent alluvium or delta material—usually is found on bottom land along river valleys, also as dyke lands along sea shores. Horizontal layers varying in texture, can often be observed in the subsoil. The colour of the soil changes gradually with depth and the soils are generally unlike the surrounding uplands. Stones are usually absent and the topography is level.

The mineral characteristics of the soil material is often important, but this is more difficult to determine. For practical purposes, it may be sufficient to determine whether the soil material contains free lime or not. If lime is present the soil material will effervesce, that is give off bubbles, when dilute hydrochloric (muriatic) acid is dropped on it.

Depth of Soil

The depth at which the surface soil changes in colour, in organic matter and structure is important, and, as a general rule, the fertility increases with greater depth of the surface soil. In many cultivated fields, especially in Eastern Canada, plough depth can be considered as the depth of the surface soil. The thickness of visible layers in the soil, due to colour, structure or textural differences, are often of great importance and should be observed. The proximity of the bedrock to the surface of the soil is often the limiting factor in determining the value of the land. The depth of soil over bedrock needed, depends on climatic conditions, texture of the surface soil and the nature and the stratification of the bedrock. Some fairly good agricultural soils are only about 3 feet deep over bedrock, while some soils of greater depth are marginal agricultural land.

Soil Colour

The colour of the surface soil is very important in determining the value of the land as it is very often an indication of soil fertility. In many cases,

especially in the prairie zones, the colour of the soil is closely related to the amount of organic matter and nitrogen present. The darker the soil, the higher, usually, the amount of organic matter and nitrogen, and consequently the higher the natural fertility. Although the latter relationship also holds generally true in Ontario, and to a lesser extent, in Quebec and the Maritime Provinces, the darker soils here are usually also an indication of poorer drainage conditions. In the Eastern Provinces, many dark soils, although well supplied with organic matter, may not be productive or suitable for certain crops because of poor drainage. In the Maritime Provinces, many surface soils are red or reddish brown in colour. This condition is often due to the influence of the mineral material from which the soil has formed and is no indication of the organic-matter content. The grey colour of cultivated surface soils in Eastern Canada and in the grey wooded soil zone in the west, as well as the presence of a grey layer near the surface in wooded areas, is an indication of leaching. The depth of the leached layer and the intensity of the grey or white colour usually are in a direct relationship with the fertility of the soil. The intensity of the grey colour changes with the moisture conditions of the soil. A soil, which is light grey to white under dry conditions, may often appear to be dark when wet.

The colour of the subsoil should also be observed, as it often gives a good indication of the drainage conditions and the aeration of the soil. A discoloured or mottled subsoil indicates that the soil is not very well drained internally, or that the soil has formed under poor drainage conditions, although at present the drainage may have been improved by artificial means. Well-drained soils usually have a more or less uniform brownish or yellowish sub-surface soil.

Soil Texture

Soil texture refers to the degree of fineness of the individual soil particles or textural constituents. The soil is made up of clay, silt, sand and gravel, which may be present in various percentages to form different combinations which are known as soil classes. From experience, it has been found that certain combinations of the different textural constituents (gravel, sand, silt and clay) are closely related with other soil properties, such as its ability to hold moisture, its power of cohesion, its ease of cultivation, etc.

The different combinations of textural constituents that can occur are shown in the attached chart, which also indicates the recognized soil classes.

The different soil classes can be determined in the laboratory with a fair degree of accuracy, but the determination of soil textures or soil classes in the field is more difficult. Reliable identification of soil textures in the field is an art and can only be accomplished after much practice and with considerable experience. However, the following soil characteristics will provide a rough guide for the identification of soil textures.

Heavy clay (50 per cent or more of clay) when wet, is very smooth and sticky. It can be pushed out between thumb and index finger into thin, narrow, shiny ribbons. It has no detectable grit. When dry, the heavy clay becomes very harsh and hard, and forms shrinkage cracks.

Clay (30 per cent to 50 per cent of clay, less than 50 per cent of sand or silt), when wet, is also sticky, but usually to lesser degrees than the heavy clay, and often a slight grit can be detected. It also forms ribbons between the fingers, but the ribbons are usually thicker. It also forms shrinkage cracks on drying and becomes harsh and hard, but not to so great an extent as the heavy clay. These properties of both soils are to a considerable extent affected by the amount of organic matter present.

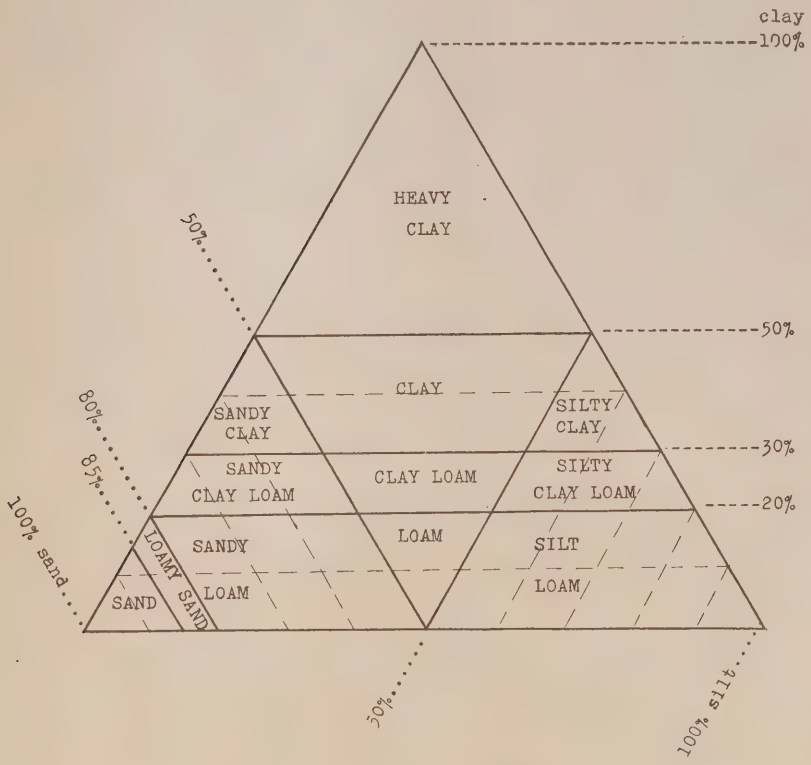
Sandy clay (over 30 per cent clay and over 50 per cent of sand) is somewhat less sticky and contains more sand than the clay, which gives it a gritty feel.

Silty clay (over 30 per cent of clay and over 50 per cent of silt) is much smoother than the clay and not quite so sticky when wet, and more friable when dry.

Clay loam (20 per cent to 30 per cent of clay and less than 50 per cent of silt or sand) is not so sticky and smooth as the clay when wet. It does not form long ribbons between the fingers, but it can be rolled into thin, stable spindles. It is somewhat gritty and when dry it does not become so harsh and hard as the clay.

Silty clay loam (20 per cent to 30 per cent of clay and over 50 per cent of silt) is slightly smoother and softer than the clay loam. When moist it will retain the imprints of the thumb.

Sandy clay loam (20 per cent to 30 per cent of clay and over 50 per cent of sand) is more gritty than the clay loam, but it still retains the stickiness of the latter.



KEY TO SOIL CLASSES

Showing Percentages of Sand, Silt and Clay in Each Soil Class

Examples:

Clay loam—contains 20 to 30 per cent of clay and less than 50 per cent of sand and silt.

Silt loam—contains less than 20 per cent of clay and over 50 per cent of silt.

Loam (less than 20 per cent of clay and less than 50 per cent of sand or silt) is only slightly sticky. It cannot be rolled into stable spindles and if a ball of moist loam is dropped it will break. When dry it does not become very harsh and hard, but tends to remain fairly loose and friable.

Silty loam (less than 20 per cent of clay and over 50 per cent of silt) remains very smooth and soft when dry or wet. It cannot be rolled into stable spindles but it retains visible finger prints when moist.

Sandy loam (less than 20 per cent of clay and over 50 per cent of sand) possesses very little cohesion and remains friable under wet and dry conditions. It is very gritty and individual sand particles are visible.

Loamy sand (less than 20 per cent of silt and clay) possesses very slight cohesion.

Sand (less than 15 per cent silt and clay) lacks cohesion and when dry it will run freely from the hand. Individual sand particles are obvious.

The sand in soils may vary greatly in size and may be classified as coarse, medium, fine and very fine. Thus, there are coarse sandy loams, fine sandy loams, etc. If a soil contains 30 per cent or more of fine, medium or coarse gravel particles up to 2 inches in diameter, the term "gravelly" is prefixed to the soil class, i.e., gravelly sandy loam, gravelly loam, etc.

Some soil classes occur more frequently than others. For example, the sandy clay loam and sandy clay occur comparatively seldom. Although the recognition of correct soil textures is generally important, it may be considered to be more important to recognize differences in texture on the prairies than in Eastern Canada, because the moisture-holding capacity of the soil depends to a large extent on the texture.

The clay soils are usually hard to handle, and they should not be worked when too wet. They have the capacity to hold considerable moisture and water percolates through them with difficulty. As a result, the clay soils in Eastern Canada and in the grey wooded soil zone are often imperfectly to poorly drained and they are also cold and slow to warm up in the spring. In the drier soil zones of the Prairie Provinces, the clays are preferred because of their high moisture-holding capacity. The clay soils are usually well supplied with plant food and they are very durable. Certain crops are better suited for clay soils than other crops.

The sands are always easily worked and they tend to warm up early. They hold very little moisture and water passes through them readily; as a result, the sands are often droughty and tend to blow more easily than the other soils. These conditions are especially of great importance in the drier soil zones of the Prairie Provinces. The sands generally contain little plant food and they are comparatively infertile. Certain crops, such as potatoes and early garden and fruit crops are better suited for sands than some other crops.

The loams are intermediate in their properties between the sands and clays. The sandy loam soils possess properties more closely related to the sands, while the clay loam soils are in many respects more closely related to the clays. A large percentage of our agricultural soils are loams. They are often spoken of as all-around soils and they are adapted to a greater variety of crops than the clays and sands.

Soil Structure

The soil structure refers to the arrangement of individual soil particles into aggregates. These aggregates or structures may vary in size and shape and they also differ in their degree of stability. Most soils have a tendency to form specific kinds of structures under certain moisture conditions. The different

kinds of soil structures often have an important bearing on the productivity of the soil and they should, therefore, be noted.

The most important soil structures which should be observed are:

1. *Powdery*—where the surface soils break up into a powdery mass. Such soils will blow easily and tend to bake when wet.

2. *Single-grained*—where the individual soil particles do not adhere to form aggregates. This indicates a lack of organic matter.

3. *Granular*—where the soil breaks into irregular shaped, small granules or crumbs. This structure is very desirable.

4. *Nut-like*—irregular shaped, slightly rounded, blocky structure, somewhat larger than granular. Indicates good drainage in the subsoil of Eastern soils.

5. *Fragmental*—about same size as nutty structures, irregularly shaped with sharp angles and corners. Such soils usually have a high clay content and are low in organic matter.

6. *Cloddy*—irregular aggregates, larger than nutty or fragmental. Resists wind erosion on prairie soils.

7. *Massive*—large cohesive masses of more or less amorphous (shapeless) soil. Such soils are often hard to work, and have impeded drainage.

8. *Column-like*—usually found in subsoils of prairie soils. Aggregates resemble vertical columns. Note whether rounded on top and along sides, also note whether top is grey. They vary in size; note whether small, medium or large. If columns are rounded and grey, they indicate a degraded alkalized soil.

9. *Platy*—Thin horizontal plates, often very crumbly. Usually found in surface of leached soils.

In addition, note whether the subsoil is deposited in parallel, horizontal layers, which are referred to as varves. The soil tends to break along the horizontal cleavage lines between the individual layers.

The subsoil sometimes becomes cemented into a solid mass to form a hardpan. If such condition is present, it should be noted.

Soil Consistency

Soil consistency refers to the condition of the soil in respect to its friability, which often has a great influence on the productivity of the soil.

Thus, it should be noted whether a soil is crumbly, friable, mellow, soft, firm, tough, hard, compact, cemented, sticky, plastic or brittle, impervious or porous.

Soil Reaction

Soil reaction refers to the acidity or alkalinity of the soil. A high degree of acidity or alkalinity usually limits the production of certain crops, and it is, therefore, important to obtain an estimate of the soil reaction.

A satisfactory estimate of the soil reaction for most practical purposes can be made quite easily in the field.

For the determination of soil reactions, in the field, place a small amount of soil on a folded piece of wax paper, and add a few drops of an indicator solution, which can be obtained for this purpose, and shake gently. The indicator solution will change in colour depending on the reaction of the soil and attains a certain colour at definite degrees of acidity or alkalinity. After a few minutes compare the colour of the indicator solution on the wax paper with a standard colour chart, which can be obtained with the indicator solution. The degree of acidity or alkalinity can then be read directly off the colour chart. Use the following indicator solutions:

For very acid to moderately acid soils—Bromcresol Green Solution.
For moderately acid to slightly acid soils—Chlorphenol Red Solution.
For slightly acid to slightly alkaline—Bromthymol Blue Solution.

Generally, the bromthymol blue is of most value for the prairie soils, and the bromcresol green is of most value for the Eastern soils. Besides the above, other indicators are available.

Another simple test is to drop some dilute hydrochloric (muriatic) acid on the soil. If the soil effervesces, or gives off bubbles, carbonates of lime or magnesia are present, which is an indication that the soil is not acid.

Drainage

Drainage plays a very important role in the productivity of the soil. Poor drainage acts not only as a physical handicap, but it also determines, to a large measure, many inherent soil characteristics. It can often be related to the colour of the surface soil and the amount of organic matter present, to the extent of leaching and consequently the amount of plant food in the soil, to the ability of the soil to warm up, to the movement of air through the soil, and to the activity of micro-organisms in the soil. Soil drainage and most of the soil properties associated with it are especially of great importance in Eastern Canada and in sections of British Columbia where precipitation is high and in the northern parts of the Prairie Provinces, where the evaporation is low. In these sections of the country, a large percentage of the land has a limited agricultural value, due to poor drainage.

The surface drainage of the soil can usually be easily determined as it is closely related to the slope of the land and the ease with which the water can run off. The surface drainage varies from rapid through good to poor. It also depends to some extent on the ability of the soil to absorb water.

The internal drainage of the soil is somewhat more difficult to determine and it is not always related to slope, although as a rule depressional and level areas are more frequently poorly drained than sloping land. The internal drainage is closely related to the ability of the soil to absorb moisture and to the porosity of the soil. Deep, friable, gravelly and sandy soils are usually well drained to excessively drained. Clay soils, through which water percolates slowly, have an impeded to poor internal drainage on level to depressional topography in the more humid areas. The internal drainage is also greatly affected by the compactness of the subsoil, and especially by the difference in compaction between the surface and the subsoil. Such conditions may cause a high water-table in depressional areas, or they may cause seepage on slopes which are ordinarily associated with well-drained land.

Poorly-drained soils often can be recognized by their typical vegetation. The surface of poorly-drained soils in the more humid regions is either darker than that of the surrounding well-drained soils (dark brown or black) or it may be light grey to white. The poorly-drained soils usually have a mottled or discoloured subsoil. The intensity of the discoloration and its proximity to the surface are indications of the degree of poor drainage. The mottling consists of brown, red, rusty, bluish or greyish specks and streaks.

The drainage conditions are usually indicated as excessive, free, good, restricted or slow and poor. Very poorly drained soils are usually referred to as swamps or bogs.

In observing drainage conditions, the ease with which the drainage can be improved should also be indicated. Some soils can easily be drained with open surface drains, while others require underdrains for satisfactory results.

After the drainage conditions have been improved, some soils are very valuable, and they may be more productive than the adjacent well-drained land. On the other hand, other soils will remain marginal or even submarginal land after the improvement of the drainage conditions.

Topography

The topography of the land is an important feature that has an effect on the value of a property as it has a great bearing on the physical adaptability of the land and on the soil and its properties. The topography affects the soil in many ways. A soil on a steep slope will retain less moisture than the soil on level or depressional land, and this has an influence on many properties of the soil, such as depth, colour, drainage, etc. Also, a soil on a slope is liable to be subjected to erosion, while level or depressional land seldom suffers from water erosion, and in many cases eroded material may accumulate on it.

The following classes are usually used to indicate variations in topography:

Nearly level to level—no appreciable differences in elevation; external drainage slow to poor.

Undulating—gentle rises and drops in elevation; surface drainage fairly good but not free; offers no handicaps to farm machinery; undulating may be subdivided into gently undulating and strongly undulating.

Rolling—rise and drop in elevation somewhat greater and slightly more abrupt; surface drainage free; handicap to heavy farm machinery. Often subdivided into gently rolling, rolling and strongly rolling.

Hilly—large and fairly steep rises and drops in elevation; surface drainage excessive; serious handicap to most common farm machines.

In the examination of individual farms, it is more desirable to note the approximate degree or percentage of slope. Also note the frequency or the length of the slopes.

Soil Erosion

Many Canadian soils have suffered considerably from erosion. The damage caused by severe erosion has, in many cases, a permanent effect on the productivity of the soil, while in cases of slight erosion, the productivity of the soil can gradually be built up again. It is therefore, very important to indicate the extent to which erosion has taken place on a particular property.

Soil erosion may be caused by wind or water. Wind erosion has been very widespead in the brown and dark brown zones and to a less extent, in the black soil zone of the Prairie Provinces. In the Eastern Provinces, wind erosion damage is more confined to very sandy soils in more or less isolated areas.

The following degrees of wind erosion should be observed:

1. *No erosion.*
2. *Slight Erosion*—little damage to soil or crop; patchy surface drifting but no serious or widespread loss of soil.
3. *Moderate Erosion*—definite damage to soil and crop. Part of surface soil removed and original structure destroyed. Fence accumulations 6″ or more.
4. *Severe Erosion*—most of surface soil removed over whole area and in places subsoil exposed. Accumulations up to 3 feet.
5. *Very Severe Erosion*—entire soil destroyed and cultivation impossible. Part of subsoils removed or covered up with dunes 3 to 6 feet high.

Certain soils are much more erosive than others, and many of such erosive soils which to date have not eroded, will do so if the proper preventive measures are not carried out.

Water may cause gully erosion or sheet erosion. Gully erosion is easily noticeable as the gullies or channels are very striking, even to the casual observer. The extent to which gullying has taken place should be observed.

(1) Gullies which can be crossed but not obliterated with ordinary farm implements. (2) Gullies which cannot be crossed with ordinary farm implements and which have penetrated into (*a*) compact subsoil or (*b*) friable subsoil. The frequency of occurrence of gullies and whether they have been stabilized with grass, trees, or shrubs, or whether they are bare should also be observed.

Sheet erosion is more difficult to detect than gully erosion as thin layers are removed from the entire soil surface and close observation is necessary.

Sheet erosion may be:

1. *Slight*—less than 25% of topsoil removed.
2. *Moderate*—25%-75% of topsoil removed.
3. *Severe*—75% or more of topsoil removed, and part of subsoil may be exposed or in places removed.
4. *Very severe*—All of topsoil removed and the upper part of subsoil removed in many places.

Stoniness

The number and size of stones present on the land greatly affect the agricultural value of a piece of property. The extent to which the stones interfere with farm operations depends to a large extent on the type of farming practised.

The following degrees of stoniness are usually recognized:

1. *Stone-free.*
2. *Occasional stones*—do not interfere with cultivation; removal not required except for an occasional boulder.
3. *Moderately stony*—interferes with cultivation; removal required.
4. *Very stony*—serious handicap to cultivation; removal difficult and expensive.
5. *Excessively stony*—non-arable land; removal too difficult and expensive for ordinary farming.

According to their size, the stones may be classified as shown below:

Size of Stones	*Rounded*	*Angular*
Up to 2″	Gravel	Gravel
2″ to 4″	Pebbles	Shingles
4″ to 8″	Cobbles	Rubbles
Above 8″	Boulders	Boulders

Rock outcrop—if the underlying bedrock protrudes to the surface.

Natural Vegetation

The natural vegetation usually has a great effect on the soil and the properties of the soil can often be estimated by the kind of natural vegetation that is found on the land. It is, therefore, important to indicate, where possible, the kind of trees, shrubs, grasses or weeds that grow on the uncultivated land of a farm. If cultivated soils lie adjacent to undisturbed permanent pastures or woodlots which appear to have a similar soil and which have similar slopes and drainage conditions, it is very desirable to indicate the natural vegetation on the adjacent land. Old hay meadows and pastures often revert back to their original vegetation or assume a new vegetation which, in many cases, reflects the fertility of the soil. The trees, bushes, grasses and weeds growing along fences also often give a fairly good guide which helps to interpret the natural fertility of the soil.

Kind of Crops Grown

Different soils are not equally well suited for the production of different farm crops. Some soils are more productive when planted to one particular crop than when planted to other crops, while other soils are equally well suited to a wide variety of crops. Years of experience have taught many farmers what crops do reasonably well on their soils, and these are the crops usually grown. This is, however, not always true. Frequently soils are planted to crops for which they are unsuited, and the condition of such crops is usually poor. In other cases, a soil may be very well suited for a certain crop yet through ignorance of this fact or perhaps for other reasons of his own, the farmer choses not to grow this crop. Thus, by observing the kind of crop that is grown on a farm, a fairly good idea can be obtained as to whether the soil is suitable for the crop or not. Other crops which have not been grown on the farm may or may not be suitable for the soil.

Present Soil Fertility as Indicated by Crop Growth

The yield and quality of a crop that is grown on a farm is the ultimate expression of the fertility and productivity of the soil. If the yield is high and of good quality, it is usually taken that the soil is fertile; on the other hand, if the yield is low, it is usually presumed that the soil is infertile. In judging the fertility of the soil by the condition of a crop, one must, of course, first of all consider whether that particular crop is suited to the soil, as has been discussed earlier. But it is also equally important to know how such crop has been produced. In other words, did it require much fertilizer, manure or other special farm practices to produce the given crop? The value of a soil which will produce a 40-bushel crop of oats without any fertilizers or special treatments will vary greatly from the value of a soil that produced a 40-bushel crop of oats only after receiving special treatments of fertilizers, manure, etc. To illustrate the point further one may take two fields on adjacent farms in Eastern Canada in which the soils originally were alike and which at present are not unlike in general appearance; that is they may have the same textures, acidity, slope and drainage. The soil on one farm has been well managed over a period of years and by the use of a good rotation and periodical applications of manure and fertilizers, its natural fertility has been maintained or increased. The soil on the second farm has been poorly managed and very little of the plant food which has been removed by crops has been returned to the soil; in other words, the soil has been depleted. The well-managed farm may produce, for example, 60 bushels of oats, while the poorly-managed farm may yield only 30 bushels of oats per acre. In this case, it is again not fair to evaluate the soils entirely on their present yields. In all probability a good new settler could, over a period of years, increase the productivity of the soil on the poor farm so that its yields will approximate those of the first farm. On the other hand, a poor settler on the first well-managed farm can, by poor farming methods, deplete the soil in a comparatively short period, so that its yield will approximate the present yields of the second farm. Although these two soils cannot be evaluated on their present yields, some definite allowances must be made for the higher state of the present fertility of the one soil. It cannot be stressed too greatly that, in estimating the condition of farm crops, the past history of the land should be given careful consideration.

Chemical Tests in Relation to Soil Fertility

The productivity of a soil is to a large extent dependent on the supply of plant food that becomes available during the cropping season. Comparatively recently in some sections of the country "rapid" or "quick" chemical soil tests have been used extensively for determining nutrient deficiencies and

fertilizer requirements of soils. The results of such tests may often be of value if the tests are made by experienced technicians and interpreted by someone with a good knowledge of soil conditions and with a wide experience in evaluating the various factors influencing the growth of crops. However, in themselves, the results of such tests cannot be used successfully for determining the fertility of a soil or the best system of fertilizing a particular soil or an individual crop. In fact, there is no known method of chemical soil analysis which in itself will furnish this information, but in conjunction with other information chemical tests are often valuable guides in interpreting the potential fertility of the soil.

SOIL SURVEY ORGANIZATIONS IN CANADA

Ottawa.—Soil Survey, Field Husbandry Division, Central Experimental Farm.

Nova Scotia.—Soil Survey, Nova Scotia Agricultural College, Truro.

New Brunswick.—Soil Survey, University of New Brunswick, Fredericton.

Quebec.—Soil Survey, Department of Chemistry, Macdonald College.

Quebec.—Soils Laboratory, Ste. Anne de la Pocatiere, Department of Agriculture.

Ontario.—Department of Chemistry, Ontario Agricultural College, Guelph.

Manitoba.—Department of Soils, University of Manitoba, Winnipeg.

Saskatchewan.—Department of Soils, University of Saskatchewan, Saskatoon, Sask.

Alberta.—Department of Soils, University of Alberta, Edmonton.

British Columbia.—Soil Survey, Department of Agriculture, Victoria, or University of British Columbia, Vancouver.

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